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A Review of Techniques for Preventing Cormorant Depredations at Aquaculture Facilities in the Southeastern United States

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Abstract.—Control strategies to reduce predation by wintering Double-crested Cormorants (*Phalacrocorax auritus*) include use of frightening devices to harass the birds at the damage site and overhead wire barrier systems to exclude them. Pyrotechnics, human effigies, gas cannons, and live ammunition have been used with varying degrees of success in frightening cormorants. Important points when using frightening strategies include the timing of their application and the choice of devices employed. An aggressive and integrated frightening program is essential. Dispersing cormorants from their nighttime roosts has been shown to be effective in reducing cormorant numbers in the foraging area of the roost. Other potential control strategies include the use of buffer prey populations and modifications in facility design and management.

Key words.—Catfish, control methods, damage management, Double-crested Cormorant, harassment, Mississippi, *Phalacrocorax auritus*, predation, roosting.

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Over the past 20 years, aquaculture has become a major industry in the lower Mississippi Valley. Catfish (*Ictalurus punctatus*) production in Mississippi has grown from a single commercial pond in 1965 to over 40,000 ha in 1991 (Wellborn 1987, Brunson 1991). Aquaculture growth in other southern states is likewise phenomenal (USDA 1992).

Double-crested Cormorant (*Phalacrocorax auritus*) populations wintering in this region have come into serious conflict with this expanding fish farming industry (Stickley and Andrews 1989). Based on producer responses and objective determinations of loss (i.e., cormorant food consumption) the annual loss to catfish production in Mississippi was estimated to be in the range of $2 to $3 million US (Stickley and Andrews 1989, Glahn and Brugger 1995). Dolbeer (1991) analyzed band recovery records to determine the migration patterns and origins of cormorants involved in these conflicts. He found that 38 to 70% of the birds recovered in the lower Mississippi Valley had been banded in Saskatchewan and adjacent regions of the Great Lakes area. These populations have increased dramatically in recent years because of decreased pesticide contamination of the environment and increased legal protection afforded the species (Ludwig 1984, Vermeer and Rankin 1984). The National Audubon Society (American Birds 1970-87, Volumes 25-41) has chronicled this buildup in numbers of wintering cormorants in Mississippi.

The intent of this paper is to provide an overview of the techniques available to reduce problems associated with winter roosting cormorants at aquaculture facilities.

CORMORANT DEPREDATION PREVENTION TECHNIQUES

Frightening Strategies

Attempts to reduce bird predation at aquaculture facilities often include the use of bird scaring devices. These devices, as described by Salmon and Conte (1981) and Littauer (1990a), include both auditory and visual stimuli. Pyrotechnics consisting of exploding and whistling projectiles are fired from handheld pistols or shotguns. Live ammunition, primarily .22 caliber rimfire cartridges, has been used in place of pyrotechnics because of its lower cost, availability, and ability to frighten birds at greater distances. Automatic propane gas exploders emit loud explosions similar to a shotgun blast at controllable intervals. Distress calls of Double-crested Cormorants, electronically generated noises, and sirens have been used to frighten cormorants with varying degrees of success.

Littauer (1990a) listed a number of visual frightening devices that have been used to limit cormorant predation. These consisted of human effigy type scarecrows, reflective tape, hawk silhouettes, helium balloons, and radio-controlled aircraft.

Although frightening devices are used most frequently in the southeastern United States to control cormorant damage, little factual data on their effectiveness exist. Moerbeek *et al.* (1987), when attempting to reduce predation by Great Cormorants (*Phalacrocorax carbo sinensis*) in the Netherlands, examined several scare devices including gas cannons, pistol-fired pyrotechnics, aircraft, and shooting. Although their data were admittedly limited, they felt that with the possible exception of ultra light aircraft these devices had insufficient deterring effects on the birds. Cormorants either did not respond to the stimuli or there was no long-term effectiveness. Stickley *et al.* (1995) evaluated an electronically-controlled, effigy type scare device during the winter months in Mississippi. During its scare routine, the blaze-orange effigy inflated to its full height of 1.7 m, bobbed up and down, and emitted a high-pitched wail before collapsing. Replicated testing of this device at catfish raising facilities showed dramatic reductions (for the 10 to 19 day duration of the tests) in cormorant numbers. However, some cormorants, usually only single birds or small groups, appeared to habituate to the device over time. Overall, this device, used in conjunction with harassment patrols, was judged superior to the use of other frightening methods such as automatic exploders or harassment patrols alone.

Cost-effectiveness should be a factor when deciding whether to employ frightening strategies and in the selection of the appropriate devices. Stickley *et al.* (1992) presented data that showed that Double-crested Cormorants in Mississippi pose a serious economic burden to catfish producers. At an average feeding rate, 100 cormorants could cause a loss of about $400 US during a 9-hour foraging day. Thus, the presence of even a relatively few cormorants represents a serious potential threat of depredation that should be met with aggressive efforts to reduce losses.

Unless the ponds lend themselves to complete enclosure with netting or wire grids, a combination of frightening approaches should be utilized. Littauer (1990b) described a continuous harassment patrol strategy that involved continuously driving the pond levees, while employing a variety of frightening devices including pyrotechnics, live ammunition, distress calls, and electronic noises. Integrated and aggressive approaches are the key words in this strategy. Frightening programs should be initiated early in the damage season before the birds establish a feeding pattern; efforts should begin early in the day; a variety of devices should be used; and the location of passive devices such as scarecrows and exploders should be changed frequently. Costs to protect a 200 ha facility with this type of harassment patrol were estimated to be $90 US per day, depending on the techniques employed, size and layout of the farm, and cormorant population size.

Despite determined efforts to disperse them, individuals or small groups may habituate to the scaring program. To minimize habituation, Slater (1980) suggested certain guidelines: (1) the stimuli should be presented as infrequently as possible, (2) the stimuli should be varied as much as possible, and (3) occasional reinforcement (such as shooting) should be included. Although supporting data were not presented, Littauer (1990b) suggested that the limited killing of birds would reinforce a scaring program.

Dispersing cormorants from nighttime roost sites is an alternate way to reduce their predation at catfish ponds in localized areas. In Mississippi, Mott *et al.* (1992) demonstrated that roosting cormorants can be easily relocated by use of pyrotechnic devices and helicopter flyovers. Compared with pretreatment, a 75 to 90% plus reduction in cormorants was recorded in the foraging areas surrounding treated roosts. This technique would be especially effective if the cormorants could be relocated to areas where they could feed on prey other than catfish (Glahn and Stickley 1995).

Exclusion Techniques

The surest way of preventing losses is to mechanically exclude the birds from the fish. Wires, ropes, strings, and nylon lines strung at various heights and configurations have been used in attempts to prevent birds from foraging at aquaculture facilities (McAtee and Piper 1937, Lagler 1939, Naggiar 1974, Barlow and Bock 1984, Moerbeek *et al.* 1987, Davis 1990).

Overhead nylon lines were evaluated by Moerbeek *et al.* (1987) in the Netherlands to determine their effectiveness in excluding Great Cormorants. Lines forming 10 x 10 m or 20 × 20 m squares, irregular patterns, and a "circus tent" design over test ponds appeared to deter large groups of cormorants from landing. However, single birds landed without apparent difficulty. The authors suggested that the lines be set closer together and 30-40 cm above the water to interfere with the birds taking flight off the ponds.

In Texas, Davis (1990) used cotton string, black plastic wire, and polymesh rope in parallel lines and a grid pattern to deter Double-crested and Olivaceous (*Phalacrocorax olivaceous*) cormorants. The lines were strung 45 to 60 cm above the water at distances of 8 to 15 m apart. Results were similar to those Moerbeek *et al.* (1987) observed in that the exclusion devices diverted larger flocks yet single birds were repelled less often. Davis (1990) felt that parallel lines were as effective as lines in a grid pattern. The spacing between lines was more important. Lines strung on 8 m centers were more effective than those strung on 15 m centers. Colored 1 to 2 m long plastic streamers attached to the cotton strings every 3 to 5 m enhanced their visibility and utility.

A 12-gauge polypropylene wire grid on 9 m spacings was constructed over a 3.7 ha fingerling catfish pond in Mississippi (May and Bodenchuk 1992). The wires were placed at a height of 2 m on removable posts to accommodate the passage of harvest and maintenance equipment. Materials to construct this exclosure cost $1,495 US ($404 US per ha), and 15.5 person days were involved in setting up the grid. Although the grid seemed to deter cormorants from landing, there were several problems with the design. The polypropylene wire stretched, which caused the lines to dip into the water. Further, the structure denied the catfish producer ready access to his pond.

Crossed and parallel wires were found not to be effective in Australia because the cormorants (*Phalacrocorax carbo, P. melanoleucos,* and *P. sulcirostris*) landed on the edge of the pond and then walked into the water, rather than trying to land on the water (Barlow and Bock 1984).

Although overhead wires were judged useful under some circumstances such as on small ponds or in protecting valuable species, the logistics of constructing a system on the larger catfish ponds (6-10 ha) in the southern United States have not been devised (Littauer 1990b, Davis 1990). Existing levees on many farms are not wide enough to accommodate poles and other supporting structures needed to span long distances. Likewise, many producers find wire barrier systems impractical due to their interference with harvesting and other cultural practices. Estimates of $2,500 US per ha to enclose a pond may make such systems prohibitively expensive (Littauer 1990b).

Netting or wire barrier systems may also pose a hazard to target and nontarget avian species. Ospreys (*Pandion haliaetus*) and swallows (Hirundininae) have been injured or killed after inadvertently striking the wire or becoming entangled in the netting (D. F. Mott, unpubl. data).

Use of Buffer Prey to Reduce Damage

The concept of using noncommercial prey species as a buffer to protect aquaculture stocks has been suggested as a solution to bird predation (Lagler 1939, Jurek 1974, Barlow and Bock 1984). Although not evaluated, Lagler (1939) mentioned the possibility of creating buffer populations of frogs, toads, and forage fish around ponds to reduce bird feeding on aquaculture stocks. Jurek (1974) recommended that Mosquito Fish (*Gambusia affinis*) be introduced near fish raising facilities to establish a buffer population of abundant prey for fish eating birds. Barlow and Bock (1984), in studying the foraging habits of cormorants on farm ponds in Australia, concluded that buffer populations of crustaceans (primarily Crayfish *Cherax destructor*) would decrease predation on fish.

In studying the diet of Double-crested Cormorants in relation to the catfish industry in the southeastern United States, Glahn *et al.* (1995) noted that Gizzard Shad (*Dorosoma cepedianum*) comprised a large portion of the cormorant diet. Their study suggested that cormorants forage on items most available to them and that shad were an important buffer to cormorant predation on catfish. The use of shad populations in catfish ponds to reduce damage on catfish, however, is a controversial and not well understood subject. Although catfish ponds stocked with shad may perform as well or possibly even better than those ponds stocked only with catfish (C. Engle, pers. comm.), most catfish producers would probably be reluctant to increase or establish shad populations for fear of attracting more cormorants to their facility. Answers to questions concerning risks of increased predation, expanded disease problems, and depleted pond oxygen are needed.

Shad production, as a buffer to cormorant predation, could, however, be encouraged in nearby natural lakes or unused ponds. The availability of shad or other noncommercial prey in areas other than catfish ponds probably also improves the effectiveness of other control strategies. Cormorants should be easier to frighten from catfish ponds when alternate prey such as shad are readily accessible in nearby lakes and rivers.

Environmental Controls

Methods of damage prevention under this category include considerations given to the initial design of the fish-raising facility and management of the fishery stock.

Salmon and Conte (1981) recommended constructing ponds in a rectangular, rather than square, shape, since there is more shoreline in a rectangle from which to harass birds. Likewise, overhead wire or netting systems can be more easily established on rectangular ponds, which have shorter distances to span.

Because cormorants seem to avoid human activity especially when harassed, recommendations were made to stock the more vulnerable fish (i.e., fingerlings) near the center of human operations and near buildings (Salmon and Conte 1981, Moerbeek *et al.* 1987). Larger fish (>25 cm) are less preferred and usually require less protection (Salmon and Conte 1981, Glahn *et al.* 1995).

In Mississippi, Glahn *et al.* (1995) reported the highest consumption of catfish fingerlings occurs during late winter and early spring just before the cormorants migrate out of the area. This foraging coincides with increased stocking of ponds at this time. Delaying this stocking until after the birds leave the area would reduce this predation provided their current migratory patterns do not change.

Stocking rates of ponds have been reported to be directly correlated with the amount of bird predation occurring (Lagler 1939, Barlow and Bock 1984). The more fish in a body of water, the greater chance for predation. Increased visibility of the fish to the birds and ease of capture are probable causes for higher predation on these ponds. For these reasons, reduction of stocking rates (primarily of vulnerable size classes) might be considered in areas of high bird pressure. Likewise, the use of water dyes or methods to increase water turbidity may reduce the visibility of fish and cormorant predation.

CONCLUSIONS

Although a number of techniques and procedures exist to reduce the extent of cormorant depredation at aquaculture facilities, none, by themselves or in combination with others, have been found sufficiently effective to resolve the conflict. At best, these actions only serve to mitigate fisheries-cormorant problems in the short term.

Currently, the Animal Damage Control program of the U.S. Department of Agriculture is continuing to further develop and assess strategies to reduce the real and potential effects of cormorants on fish farming operations to an acceptable level. Management approaches must be evaluated with extreme care to ensure the successful attainment of cormorant depredation prevention goals over the longer term.

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